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Postprint / Postprint
Zeitschriftenartikel / journal article

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Empfohlene Zitierung / Suggested Citation:
Bermeitinger, C., Goelz, R., Johr, N., Neumann, M., Doerr, R., & Ecker, U. K. H. (2009). The hidden persuaders break into the tired brain. *Journal of Experimental Social Psychology*, *45*(2), 320-326. https://doi.org/10.1016/j.jesp.2008.10.001

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Accepted Manuscript

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PII: S0022-1031(08)00205-9
DOI: 10.1016/j.jesp.2008.10.001
Reference: YJESP 2176

To appear in: *Journal of Experimental Social Psychology*

Received Date: 30 July 2007
Revised Date: 22 September 2008
Accepted Date: 1 October 2008

Please cite this article as: Bermeitinger, C., Goelz, R., Johr, N., Neumann, M., H. Ecker, U.K., Doerr, R., The hidden persuaders break into the tired brain, *Journal of Experimental Social Psychology* (2008), doi: 10.1016/j.jesp.2008.10.001

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RUNNING HEAD: Subliminal Persuasion

The hidden persuaders break into the tired brain

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Word count (main text):

4657

Word count (footnotes):

651

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Abstract

There is a long-lasting debate on whether subliminal advertising actually works. In this context there are some studies suggesting that subjects' motivation is a crucial point. Karremans, Stroebe, and Claus (2006; JESP) showed that subjects were influenced in their intention to drink a specific brand of soft drink by a subliminally presented brand prime, but only if they were thirsty. In the present study, we adapted their paradigm to the concept of 'concentration' and embedded the subliminal presentation of a brand logo into a computer game. Actual subsequent consumption of dextrose pills (of the presented or a not presented brand) was measured dependent on the level of participants' tiredness and the subliminally presented logo. We found the same pattern as Karremans et al. (2006): Only tired participants consumed more of the subliminally presented than the not presented brand. Therefore, the findings confirm that subjects are influenced by subliminally presented stimuli if these stimuli are need-related and if subjects are in the matching motivational state.

Keywords: subliminal priming; subliminal persuasion; advertisement; subliminal advertising; need-related subliminal stimuli; level of tiredness; motivation for concentration enhancement

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Recently, Karremans, Stroebe, and Claus (2006) revived the debate about subliminal persuasion. They connected the subliminal priming of a brand name and the choice of this brand over control brands with participants' goals or needs: Only thirsty participants (who were thought to have the specific goal to quench their thirst) chose the primed drink over the others more often. Considering the history of findings around subliminal persuasion, to replicate and even extend or generalize the found effect seems both challenging and vital.

Indeed, there is a long-lasting debate on the possibilities and boundaries of subliminal advertising (for reviews, see Dijksterhuis, Aarts, & Smith, 2005; Theus, 1994). The well known story of the marketing expert James Vicary represents a milestone of this debate. He claimed that he had increased the sales of popcorn and Coca Cola by 57.7% and 18.1% after the subliminal presentation of the slogans "Drink Coca Cola" and "Eat Popcorn" in a movie (e.g., Brand, 1978; Henderson, 1957). By 1962 at the latest, this was exposed as a publicity hoax. Nevertheless, till today the story is living as a modern legend (e.g., Pratkanis, 1992; Rogers, 1993; Rogers & Smith, 1993).

Karremans et al. (2006) showed that some of Vicary's fantasies are maybe actually not so farfetched. In their first experiment, Karremans et al. (2006) presented a subliminal stimulus – for the experimental group the brand name "Lipton Ice", for the control group the neutral string "Npeic Tol" – 25 times within a visual detection task. Afterwards, participants had to make a virtual choice between Lipton Ice and Spa Rood, a common mineral water. Then, they answered questions about their intention to drink Lipton Ice, Coca Cola, and Spa Rood. Finally, the level of thirstiness was measured with two further items. There was a positive association between the amount of thirst and the likelihood to choose Lipton Ice (compared to Spa Rood) and between the amount of thirst and the intention to drink Lipton Ice only in the Lipton Ice prime condition, not in the "Npeic Tol" prime condition. In a second experiment, the authors manipulated the amount of thirst with a salty sweet (to

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increase feelings of thirst) for half of the participants. Afterwards, subjects ran through exactly the same course as in the first experiment. The main findings could be replicated: the subliminal presentation of a drink's name increased the choice-probability for this drink and the intention to drink this beverage only for thirsty individuals.

The study is perfectly in line with assumptions (and research which confirms these assumptions) that one can be subliminally influenced only if one is in a corresponding state with a selective vigilance (see Bruner & Postman, 1947); that is, if the prime is in relation to one's current goals or needs (e.g., Brand, 1978; Strahan, Spencer, & Zanna, 2002; Strahan, Spencer, & Zanna, 2005; and even Vicary himself assumed that in 1958, see Rogers, 1993).

The results of Karremans et al. (2006) represent a serious example of subliminal manipulation of choice behavior with scientific means after a long period with hundreds of mass media papers that mostly pursued this question only insufficiently (e.g., Pratkanis & Greenwald, 1988). But one could argue that the study is only one more study amongst the hundred others which were – with random assignment – sometimes able to show subliminal persuasion and sometimes not. Brannon and Brock (1994) described the problem around the lacking reproduction of a subliminal persuasion effect, fittingly, as a script for a drama with three acts: First, observation of an effect in the field; second, demonstration of the effect in a laboratory analogue; third, subsequent failure to reproduce the effect. Therefore, the vast majority of the psychological community concluded that subliminal persuasion does not and could not work (for example Broyles, 2006; Dijksterhuis et al., 2005; George & Jennings, 1975; Moore, 1988; Pratkanis & Aronson, 1992; Pratkanis & Greenwald, 1988; Trappey, 1996).

Given the lack of supporting evidence, a replication of Karremans et al.'s (2006) findings is urgently needed. Besides the importance to replicate their effect, however, the study leaves open questions and, at one point, shares a common problem that many previous

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studies have been criticized for; that is, the test of stimuli's subliminality (e.g., Beatty & Hawkins, 1989; Brand, 1978; Brannon & Brock, 1994; Merikle, Smilek, & Eastwood, 2001; Saegert, 1979). This seems to be especially important considering the fact that prime duration in their study was quite long (23 ms). There are a lot of studies in which at least some participants showed high performances in direct prime detection tests with even shorter presentation times of 17 ms (e.g., Greenwald, Draine, & Abrams, 1996).

The present research. In the present study, we wanted to take up the experiments from Karremans et al. (2006) and conceptually replicate their findings. Additionally, we wanted to expand their results; in particular, we measured the primes' subliminality in the actual prime study's participants and we measured actual consumption behavior rather than just the intention to behave.

First of all, we chose a need other than thirst to go one step beyond simple physiological needs. We decided to use the concept of 'concentration'. Tired persons need to put more effort into a task in an achievement situation than fit persons. Therefore, tired persons should have the motivation to enhance their concentration. Of course, the first wish of a tired person would be to take a rest or sleep for a while. But most often (in the lab and in everyday life as well) this possibility is no real alternative. In the lab, participants give their consent to concentrate and do the best they can. And in everyday life, you only have to imagine a night-time car journey, during which it is vital to focus on the task and mobilize your reserve resources despite fatigue. We call this motivation the 'motivation for concentration enhancement' (MfCE) and we assume that tired participants in particular have this need. This assumption was tested and corroborated with 25 subjects who did not participate in the main experiment. [1] As an equivalent to the drinks in the Karremans et al. (2006) study, we chose dextrose pills – a popular means of concentration enhancement in achievement situations.

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Second, we did not measure participants' *intention* to consume a product, but their actual consumption (of a primed and a non-primed 'product') within the course of the experiment. We consider this a more sensitive and valid measure than the virtual choice of one of two alternatives (see also literature on the intention-behavior gap; for an example in a purchasing context, see Miniard, Obermiller, & Page, 1983). First, real consumption behavior is probably less influenced by strategical thinking than virtual choice behavior. Second, we can analyze the behavior of one person regarding both primed and non-primed 'brands'. And finally, it allows us to measure behavior over a longer period of time, and also after participants have made some experience with the different 'products'.

A third difference is that we did not use common brands. The two logos we used were designed especially for this study. Additionally, one logo was subliminally presented to one half of the subjects, the other logo was subliminally presented to the other half of the subjects. This counterbalancing allowed us to compare consumption behavior between both 'brands' instead of comparing the subliminally presented brand and a further control brand (as in Karremans et al., 2006). It has been discussed that influencing someone's consumer behavior may be simpler when concerned with neutral stimuli in comparison to already familiar brands (e.g., Dijksterhuis et al., 2005). Nevertheless, we chose this procedure because our interest was the manipulation of consumer behavior in terms of a relative comparison of two (novel) brands, not regarding a change of an *a priori* preference.

Fourth, after the main experiment and for each participant, we ran a direct test to objectively assess discrimination performance regarding the two logos, as recommended by Merikle et al. (2001). Karremans et al. (2006) ran a direct test with *separate* participants, asking them to report the subliminally presented word. Our approach was to ask subjects to make a two-alternative forced choice – select the logo that was subliminally presented earlier –, which we consider a simpler and thus more sensitive task. Hence, if a participant

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successfully differentiated between the two logos (i.e., detected the critical logo), we concluded that behavior may have been based on some supraliminal details. Such an individual measure of discrimination performance also allowed us to check whether an effect hinges on participants with good or bad performance.

Last but not least, we embedded the subliminal presentation in a computer game, which constitutes a less artificial context than those used in most of the previous studies.

Method

Participants. The sample consisted of 64 (18 male, 46 female) participants from Saarland University (*Md* = 21 years, ranging from 19 to 49). They received experimental credits for their participation and had the chance to win vouchers for the movie theater. All participants had normal or corrected to normal vision. Three subjects were excluded from the analysis because of very low scores (below 3 points) on the *Inventar Komplexer Aufmerksamkeit* (INKA, inventory for complex attention; Heyde, 2000), testing concentration performance (see below); these subjects likely did not understand instructions or were not motivated to follow them.

Design. The design comprised factors 'subliminal prime' (logo A vs. logo B) and 'level of tiredness' (continuous variable based on participants' self-rating). Each participant was shown either logo A or logo B. The number of consumed dextrose pills from product A and product B ('consumption') served as the dependent variables.

Material. We designed ten colored logos (each with a graphical background and the writing 'Dextro') that were tested in a pretest with 39 subjects who did not take part in the main experiment. Two logos (for black-and-white versions see Figure 1) were selected as subliminal stimuli because of comparable preferences in the pretest. Both logos could be imagined as logos for a dextrose brand and they were chosen equally often as the preferred logo. The logos did not differ with regard to their size (7.9 cm in width, 5.8 cm in height) and

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their mean luminance. The dominant colors of both logos were black, red, white, and yellow. A mask was created by decomposing each of the two logos into 40 parts. Then, 20 parts of each logo, respectively, were newly put together (ensuring that darker parts were predominantly used for outer areas of the image, as in the original logos; for a black-and-white version see Figure 1c). Dextrose pills with a diameter of 2 cm, a weight of 2 grams, and a slight citric taste served as products that could be consumed during breaks. They were offered in two small bowls positioned side-by-side on the left-hand side of the monitor; the bowls were covered until the first consumption break. Each bowl contained 10 pills; one of the logos (defining product A and product B, respectively) was pasted onto each bowl; the positioning of bowls (i.e., the assignment of logos to left/right bowls) was counterbalanced across subjects.

For the presentation of the subliminal logos, we designed a simple two-dimensional jump-and-reach computer game in E-Prime (version 1.1, SP 3, Psychology Software Tools, Inc., Pittsburgh, PA, USA). In this game, a green avatar manikin (3 cm in height) walked on a gray wall (which occupied the lower 6 cm of the screen) and jumped when the up-arrow-key was pressed. By doing so, the manikin could collect bundles of banknotes that flew into the screen from the right-hand side. For each collected bundle, one point was added to the playing score (which was shown in the right-upper corner). Additionally, the manikin had to jump over campfires that also emerged on the right-hand side. Two points were taken off the score if the manikin did not succeed in doing so. To make it more difficult, the speed of the incoming objects was increased with increasing duration of the game. The background consisted of flickering flames to conceal the subliminal stimulus presentations.

The logos and the mask were presented to the upper right of the manikin. This position was chosen because it was the place most likely attended by participants because the game objects (i.e., notes and fires) appeared on the right-hand side.

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Procedure. Participants were tested in groups of up to four people. The experiment was run on IBM-compatible PCs using E-Prime software and 17'' monitors with a refresh rate of 100 Hz. Unless otherwise noted, all instructions and tasks were given on the computer screen.

In the first phase, subjects gave their consent to participate voluntarily and with their full engagement. Participants were told that the goal of the experiment was to test if the individual self-determined consumption of dextrose influenced concentration and performance in a computer game. They were told that we had two different sponsors for the dextrose pills (which nevertheless had similar taste and composition), such that they had two different products to choose from. Subjects were additionally motivated with the chance to win vouchers for the movie theater, which were given to the participant with the highest score within their group.

In the second phase, participants were requested to answer some questions about their actual state, their leisure time, and their consumption of various substances (e.g., coffee, tea, or energy drinks) in concentration-demanding situations. Within these questions, participants' tiredness was measured with two five-point items: "Today I am …" [-2 = well rested, 2 = not well rested], "At the moment I am feeling …" [-2 = fit, 2 = tired]. The scores on these items were averaged to create an index of tiredness.

In the third phase, participants were acquainted with the computer game with appropriate instructions and a two-minute practice block. This practice block was exactly the same as the following game blocks within the fifth phase (see below), except that the score was not included into the overall score of the participants. Within each block (i.e., during the ongoing game), there were three sequences. In the first sequence A, which lasted 30 seconds, the word "Konzentration" (concentration; 5.5 cm in width, 0.5 cm in height) was subliminally flashed on the screen in red to enhance or trigger subjects' motivation for concentration. The

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word was presented at the same position as the subliminally presented logo; presentation time was 10 ms, with an inter-trial interval (ITI) of 3000 ms. During the second sequence B (30 seconds), the word "Konzentration" and the subliminally presented logo were presented alternately: Presentation started with the logo (i.e., the prime; 10 ms), which was replaced by the mask (10 ms); after an ITI of 3000 ms, "Konzentration" was presented for 10 ms, and so on. In the last sequence C (60 seconds), only the subliminal prime (10 ms) followed by the mask (10 ms) were presented consecutively with a 3000 ms ITI.

In the fourth phase, participants received the paper and pencil version of the INKA (Heyde, 2000), a test of concentration and attention (i.e., the quality of information processing). [2] The test was in line with the cover story and was introduced to further focus subjects on the need for concentration. Instructions were given verbally and on the test sheets. The test lasted about 15 minutes.

The fifth phase comprised the main part of the experiment. There were four game blocks of 2 minutes each. The procedure was the same as in the practice block. Altogether, in each block, the word "Konzentration" was presented 14 times and the subliminal prime was presented 24 times. Between the blocks, there were consumption breaks of about 1 minute each. During these breaks, participants had the chance to consume the dextrose pills. It was emphasized particularly that it was at participants' discretion whether, how many, and which pills they chose to consume.

After the last game block and in the sixth experimental phase, participants answered some questions about the game and the dextrose brands. They were then informed about the presentation of subliminal logos and asked if they had perceived any aspects of the primes or mask.

This debriefing was followed by the seventh phase featuring a direct test of discrimination performance regarding the subliminally presented logos. Each trial was set off

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by a key press, and then a short sequence of the game was shown. Participants were instructed not to move the manikin but instead to attend to the position where the subliminal logo was presented. First, a green dot was flashed for 10 ms at that position. After a 130 ms "blank" interval, the dot was repeated for a further 10 ms. Then, after another 130 ms, one of the two logos appeared for 10 ms, followed by the mask for a further 10 ms (note that the time parameters of logo and mask presentation were exactly the same as in the game blocks). Finally, the two logos were presented next to each other on a white background and subjects had to decide (using the mouse) which logo they had just seen. This sequence was repeated 50 times, with random assignment of logos; that is, half of the trials contained the logo presented in the game, the other half contained the logo that was not presented.

Finally (phase eight), participants were fully debriefed and they were asked to maintain confidentiality concerning the true purpose of the experiment. The score of each participant was read from the monitor and the subject with the highest score was rewarded the cinema voucher. After the participants had left, the number of consumed pills from each of the two bowls was counted.

Results

Direct test of discrimination performance. For some participants, the parametric signal detection sensitivity measure *d'* could not be calculated because their hit rate or false alarm rate was either zero or one. Therefore, the non-parametric equivalent *A'* (see Pollack, 1970; Pollack & Norman, 1964) was calculated. *A'* ranges from one (perfect discrimination) to zero (perfect discrimination, but reversed keys) with *A'* = .50 denoting random responding. On average, *A'* was .47 (*SD* = 0.16), which did not differ significantly from random responding, $t(60) = 1.34$, $p = .19$. [3]

Consumption behavior. The mean number of consumed pills associated with logo A and logo B in each of the different conditions are shown in Table 1. First, we calculated the

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individual difference scores – number of consumed pills of the primed logo minus number of consumed pills of the non-primed logo. Thus, positive values indicate more consumption of the primed product than the non-primed product. These difference values were linearly regressed onto the level of tiredness (from -2 = not tired to 2 = tired). The analysis revealed a significant positive association between tiredness and the difference of consumed pills, β = .34, $t(60) = 2.79$, $p < .01$ (see Figure 2) – tired subjects consumed more of the primed product compared to the non-primed product. The constant was significant as well, $t(60) = 2.11$, $p <$ .05. The analysis yielded predicted values with a 95%-interval of confidence not including zero for tiredness values above -0.25 (see Figure 2). That is, even for those participants who were neither especially tired nor especially 'not-tired', it can be expected that the consumption of the primed product exceeds the consumption of the non-primed product.

The above regression analysis corresponds to an interaction between type of logo (primed vs. non-primed) and tiredness. Thus, we calculated the simple effects of tiredness separately for primed and non-primed logos. These analyses revealed a significant positive association between tiredness and the amount of consumed pills only for the primed logo, β = .30, $t(60) = 2.44$, $p < .05$, not for the non-primed logo, $\beta = -.04$, $t < 1$ (see Figure 3). [4]

Discussion

With the experiment we conceptually replicated the findings of Karremans et al. (2006). Only participants with a specific need or motivation chose the subliminally presented motivation-related product more often. While Karremans et al. (2006) used the basic need of thirst as the predictor, we transferred the problem to the motivation for concentration enhancement, which is higher when participants are tired – as demonstrated with an independent sample (see footnote 1). Thus, we extended Karremans et al.'s findings to arrive at a broader understanding of motivational states.

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As expected, only tired participants consumed more pills of the primed brand than the non-primed brand; not-tired participants consumed equal amounts of both products. Furthermore, the effect is clearly based on the additionally consumed primed-brand pills in the tired subsample; there was no difference between tired and not-tired participants regarding the consumption of the non-primed product. Thus, only the consumption of the subliminally primed product was influenced – not the consumption of the non-primed product. However, we do not know how the general consumption of dextrose was affected by the subliminal prime due to the lack of a control group which did not receive any prime. Therefore, it is possible that the prime per se led to an increase of dextrose consumption. Nevertheless, for tired participants, the subliminal prime affected the consumption of (additional) dextrose in a very specific manner, leading only to an increase in primed-brand consumption. This is evidence that the prime affected participants' behavior rather specifically. Importantly, we were able to demonstrate the effect of subliminal priming on *real* consumer behavior (and not only on the intention to consume) in a quite realistic context.

In contrast to Karremans et al. (2006), we checked subjects' individual prime discrimination performance directly. The low rate of participants with above-chance performance in this discrimination task shows that the chosen presentation procedure was successful in preventing conscious awareness of the logos. Additionally, analyses of consumption behavior yielded essentially the same results if participants who performed above chance in this direct test were excluded. Hence, the explanation that the effect hinges on consciously available supraliminal information is ruled out.

The prime stimuli we used were neutral and non-familiar logos that were designed especially for use in the experiment. That may have increased the chance of finding an effect of the subliminal logo, because the effect of both subliminal and supraliminal advertising is greatest when participants' attitude towards the advertised product is indifferent (e.g., Brand,

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1978). Importantly, however, logos were chosen to be equally appealing (as indicated by pretest data), they were very similar (they displayed the same word, they had similar colors, etc.), and each logo served as the subliminal prime for half of the participants and as the control logo for the other half of the participants. Consequentially, the overall level of consumption of products A vs. B was equivalent. One can therefore conclude that the material had equivalent *a priori* appeal and that the effect did not depend on a specific logo, but on the actually subliminally presented logo and the individual level of tiredness. Additionally and despite claims to the contrary (Cuperfain & Clarke, 1985), we can conclude that a subliminal stimulus does not need to have a certain *a priori* familiarity to be effective in an advertising context. In a similar vein, the present study demonstrates that fairly complex stimuli can elicit subliminal manipulation of behavior (which of course requires that participants' visual system can differentiate between stimuli, cf. Bahrami, Lavie, & Rees, 2007). This sheds further light on the question of how complex stimuli can actually be for subliminal processing (e.g., Greenwald, 1992; Cooper & Cooper, 2002).

The embedding of the subliminal presentation into a computer game seems to be an interesting and potentially momentous variation to earlier studies. Our task was in no way related to the consumption product. This constitutes a less artificial context than that used in most previous studies, which have used lexical decision tasks and the like. The fact that subjects played a computer game means that they did not focus their attention on the position where the subliminal stimuli would appear at all times, and also that they were occupied with a more complex task (including, e.g., vigilant observation of the entire scene, alternate focusing and broadening of attention, and planning of behavior) than, for example, deciding whether a string is a word or a nonword. The results thus show that subliminal stimuli can influence behavior even in conditions commonly considered to be suboptimal for the processing of subliminal stimuli. Hence, we brought the experimental situation closer to a

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more realistic advertising situation (Epley, Savitsky, & Kachelski, 1999). In that context, a limitation of our study lies in the circumstance that the subliminally primed product was actually present and directly accessible. Further research could investigate whether there is transfer to situations requiring more effort and/or (monetary) resources to obtain the actual product. Relatedly, the temporal duration of the effect needs to be determined; in fact, the use of subliminal advertising in order to manipulate consumer behavior will have to rely on subliminal manipulation of *memory* processes and representations under most circumstances. It should also be mentioned in this context that subliminal advertising is illegal in some countries (including the United Kingdom and Australia) but not others. For instance, subliminal advertising is – strictly speaking – legal in the U.S. (The Guardian, March 9, 2007), although the Federal Communications Commission (FCC) has the power to revoke a company's broadcast license (FCC, 2001). Despite its legal ban, an instance of subliminal advertising with 40 ms flashes of brand logos has been reported in Australia in 2007 (Sydney Morning Herald, February 21, 2008 [5]). This legal state may be partially due to the failure of previous studies (and meta-analyses) to yield convincing evidence for the effectiveness of subliminal advertising (see Introduction). Our study and that by Karremans et al. (2006) show that this lack of evidence may be in part due to the negligence of the motivational state of percipients.

Regarding our interpretation of the effects as motivation- or need-related, the basic question may arise if that interpretation is actually warranted. There are some studies showing that percipients' passivity or relaxation favors effects of subliminal stimuli (e.g., Brand, 1978; Fiss, 1966) and that strong needs have an 'alerting' effect such that *all* stimuli are better ingested, not just specific need-related ones (McConnell, Cutler, & McNeill, 1959). Therefore, it is possible that tired participants are more influenceable by all kinds of subliminal stimuli, not just specifically motivation-related stimuli such as brands of dextrose

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(note that the same argument would hold true for the experiments of Karremans et al., 2006, too). Although we cannot really rule out this possibility, there are some findings suggesting that subliminal primes can act in a very specific way. First, our own results show that it was not dextrose consumption per se that was affected by the subliminal prime, but the consumption of the specific product (see, e.g., Figure 3). We also successfully demonstrated the strong connection between tiredness and the motivation for concentration enhancement (at least for our test situation). Furthermore, Cooper and Cooper (2002) reported an effect of subliminal stimuli that was specific for one motivational state. The authors influenced subjects' thirst ratings by subliminally presenting the word "thirsty" and/or the picture of Coca Cola cans, but found no increase of thirst in the control group. Additionally, they measured subjects' hunger, mood, and tiredness and found no influence on these variables. The authors concluded that the motivational state changes were highly specific to the stimuli used as subliminal primes. Given the high specificity of consumption and the high specificity of motivational states that can be affected by subliminal stimuli, we believe that need-related stimuli are preferentially processed only by participants in the specific motivational state. Nevertheless, to buttress our individual difference measurement, a replicatation of our study with an experimental manipulation of tiredness seems desirable.

In sum, the present study successfully replicates and extends Karremans' et al. (2006) findings that subjects' choice of a specific product is influenced by subliminally presented information only if they are in a motivational state congruent with the subliminally presented stimulus. Hence, Brannon and Brock's (1994) "accursed" third act should be rewritten and the well known drama seems to take a new turn.

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The research reported in this article was supported by intact GmbH (Hessenweg 10, D – 48157 Muenster, www.intact-ms.de) who sponsored the dextrose pills. We thank Dirk Wentura, Christian Frings, Andrea Paulus, and Michaela Rohr, Joel Cooper and one anonymous reviewer for helpful and detailed comments on an earlier version of this paper.

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Figure captions

Figure 1.

Black-and-white versions of the stimuli designed for the subliminal presentation. (a) logo A, (b) logo B, (c) mask created from an equal number of parts of both logos.

Figure 2.

Difference of consumed dextrose pills (consumed pills of the primed product – consumed pills of the non-primed product) as a function of the level of tiredness ranging from -2 (not-tired) to 2 (tired) (bold line). Grey lines indicate the 95%-interval of confidence; the arrow indicates the level of tiredness above which the predicted value of the consumption difference (i.e., more consumed pills of the primed product than the non-primed product) is significant ($\alpha = .05$).

Figure 3.

Consumed dextrose pills associated with the subliminally presented logo (i.e., the primed logo) and the not-presented logo (i.e., the non-primed logo) as a function of the level of tiredness ranging from -2 (not tired) to 2 (tired).

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Footnotes

[1] We tested the relation of the level of tiredness and MfCE. Both were continuous variables based on participants' self-ratings. Materials and the procedure were similar to the main experiment but without the direct test of discrimination performance concerning the subliminal stimuli and without different choices of primed or non-primed pills: the dextrose pills were offered in only one bowl which was not labeled with any logo, and the bowl contained 20 dextrose pills. Subjects played the computer game and were then given 28 questions mainly targeting their effort or strategies during the game and how supporting the consumption of dextrose was. Among these, the critical question appeared: "How strong was your need to enhance your level of concentration before or during the game?" [2 = very, -2 = not at all]. Overall, participants had no significant motivation for concentration enhancement, $M = 0.28$ ($SE = 0.25$), $t(24) = 1.13$, $p = .27$. Yet, most importantly, the correlation between the level of tiredness and MfCE was significant, $r = .52$, $p < .01$; the more tired participants were, the higher was their need to enhance their concentration level. Thus, the result is perfectly in line with our prediction.

[2] This test requires participants to scan rows of consonants for specified consonants and to transform these into assigned letters via a transformation index.

[3] With respect to the individual 2 (presentation: logo A vs. logo B) x 2 (response: choice of logo A vs. choice of logo B) distribution, three participants had a χ^2 value associated with p-values below .05 (all $\chi^2 > 4.02$, all ps $< .04$) and another three participants had a χ^2 value associated with p-values below .10 (all $\chi^2 > 2.88$, all ps $< .09$). Excluding these participants from the following analysis did not change the pattern of results.

[4] To present the more conventional results of an ANOVA and to exclude interpretations concerning possible material differences, we additionally conducted a repeated measures MANOVA with the factors 'subliminal prime' (logo A vs. logo B), 'tiredness' (tired vs. not-

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tired), and 'bowl arrangement' (A left and B right vs. B left and A right), and the number of consumed pills from logo A and logo B as the dependent variables. The majority of participants (n = 40) had negative tiredness scores. We labeled this subsample 'not-tired'. There were 14 participants with positive values. These subjects were labeled as 'tired'. Seven subjects had a tiredness score of zero, that is, they considered themselves neither tired nor not-tired. This subsample was labeled 'neither-nor'. Overall, participants had a mean tiredness of M = -0.60 (SE = 0.13), which differed significantly from zero, $t(60) = 4.68$, $p < .001$, and indicates that they were on average rather non-tired. In the MANOVA, there was a significant main effect of 'tiredness', $F(1,46) = 4.95$, $p < .05$, $\eta_p^2 = .10$; tired participants consumed M = 2.31 (SE = 0.98) more dextrose pills than not-tired participants. Further, there was a significant interaction of 'subliminal prime' and 'consumption', $F(1,46) = 4.70$, $p < .05$, $\eta_p^2 = .09$. Most importantly, these main and interaction effects were qualified by a significant interaction of 'subliminal prime', 'tiredness', and 'consumption', $F(1,46) = 9.63$, $p < .005$, $\eta_p^2 = .17$. As seen from Table 1 and confirming the findings from the regression analyses, only the tired participants consumed M = 1.7 (SE = 0.56) more pills of the primed product, $t(13) = 3.07$, $p < .01$. The tendency of the not-tired subjects to consume M = 0.25 (SE = 0.27) more pills of the non-primed (compared to the primed) product was not significant, $t < 1$.

No other main or interaction effects reached significance, all Fs < 2.9, all ps > .09. Most importantly, there was no main effect of the subliminally presented logo, no overall difference between the consumption of products A and B, and no effects including the factor 'bowl arrangement'.

[5] cf. http://business.smh.com.au/business/ten-investigated-on-splitsecond-ads-20080220-1tfe.html or http://www.abc.net.au/mediawatch/transcripts/s2082405.htm

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(a)

(b)

(c)

Fig.1

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Fig.2

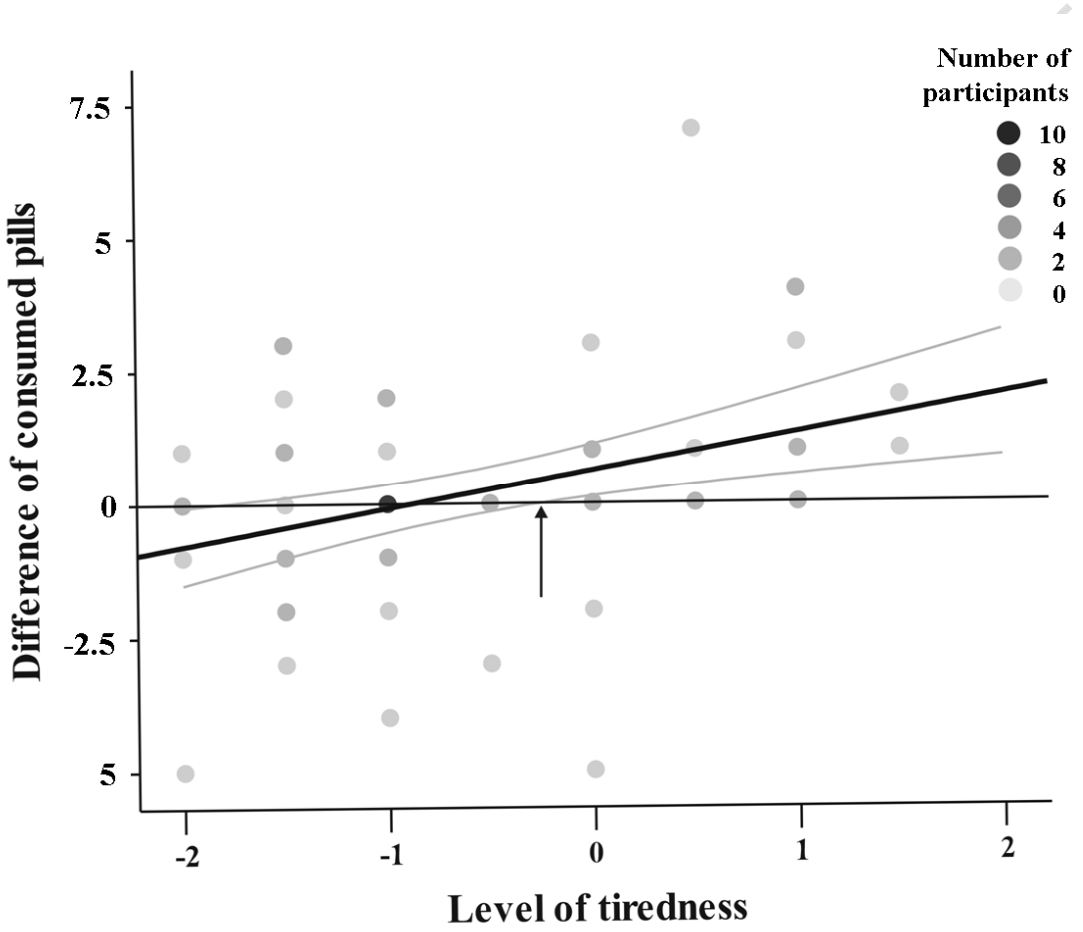

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Fig.3

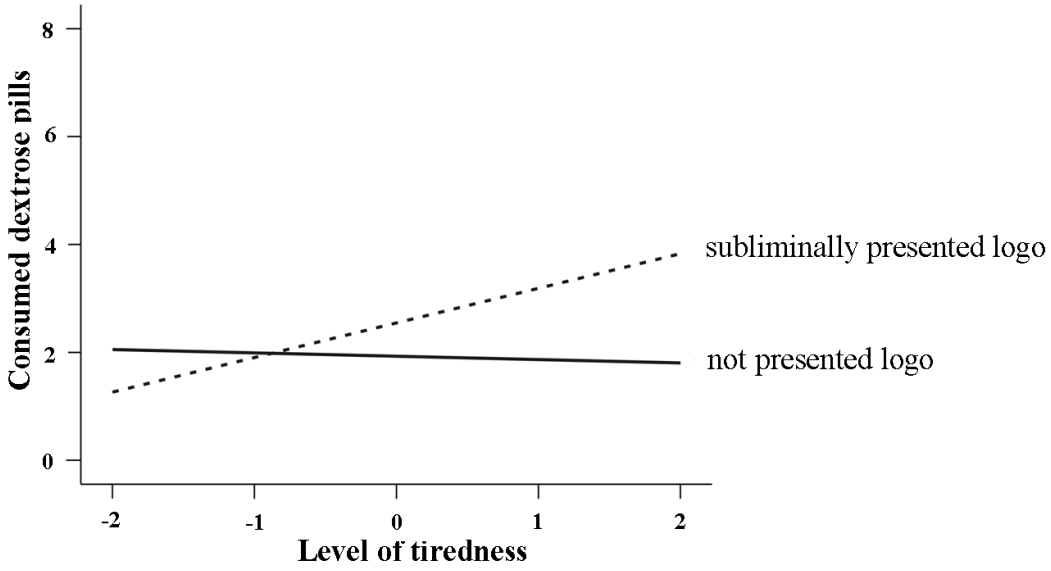

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Table 1

Mean number of consumed pills from product A and product B (standard deviation in parentheses) as a function of level of participants' tiredness (not-tired vs. tired), subliminal prime (logo A vs. logo B) and order of bowl arrangement (A left and B right = AB vs. B left and A right = BA).

		not-tired participants		tired participants	
		subliminal prime		subliminal prime	
		logo A	logo B	logo A	logo B
Consumption of					
product A	bowl order AB	2.0 (2.1)	1.8 (1.6)	4.0 (2.0)	1.0 (1.0)
	bowl order BA	1.2 (1.6)	1.8 (1.3)	4.0 (3.0)	2.4 (1.7)
product B	bowl order AB	1.8 (1.6)	2.1 (2.2)	2.0 (1.0)	3.3 (3.2)
	bowl order BA	2.1 (2.0)	1.0 (1.2)	3.0 (1.0)	3.6 (2.7)